

**REMARKS**

The Examiner is thanked for the due consideration given the application.

Claims 1-4, 9, 11, 12, 14, 18, 19 and 22-29 remain pending in the application. Claim 21 has been cancelled without prejudice or disclaimer. Claim 1 has been amended to have more restrictive transitional language, to set forth language in accordance with the Examiner's suggestion and to incorporate subject matter from claim 2. Claim 2 has been amended to stand as an independent claim. Claims 3, 4, 18 and 19 have been amended to clarify the language. Claims 22-29 are newly presented and generally correspond to subject matter from claims 3, 4, 9, 11, 12, 14, 18 and 19 in light of newly independent claim 2.

No new matter is believed to be added to the application by this amendment.

**Claim Objections**

Claim 3 has been objected to as failing to limit the subject matter of a previous claim.

The Office Action asserts that the "and/or" limitation does not further limit because claim 1 requires adsorption by the solid superacid catalyst. However, claim 3 has been amended to have an "and" limitation such that the reaction products are adsorbed by both the zeolite and the solid superacid catalyst.

**Rejection Under 35 USC §112, First Paragraph**

Claim 21 has been rejected under 35 USC §112, first paragraph as failing to comply with the written description requirement. This rejection is respectfully traversed.

Claim 21 has been canceled by this amendment, thereby rendering this issue moot.

Withdrawal of this rejection is accordingly respectfully requested.

**Rejection Under 35 USC §112, Second Paragraph**

Claims 1-4, 9, 11, 12, 14, 18 and 19 have been rejected under 35 USC §112, second paragraph as being indefinite. This rejection is respectfully traversed.

The Office Action asserts that claim 1 can have two meanings. However, claim 1 has been amended to reflect the Office's first interpretation, such that upon contacting the kerosene or gas oil with the solid superacid catalyst, the reaction between the sulfur compounds themselves or between the sulfur compounds and the aromatic hydrocarbons occurs prior to adsorption of the reaction products by the solid superacid catalyst. Newly independent claim 2 also reflects this interpretation.

The claims are thus clear, definite and have full antecedent basis.

This rejection is believed to be overcome, and withdrawal thereof is respectfully requested.

**Claim Rejections - 35 USC §103**

Claims 1-4, 9, 11 and 14-19 have been rejected under 35 USC §103(a) as being unpatentable over Toida (WO 2003/097771 - referring to corresponding US 2005/0173297) in view of Imura et al. (EP 1 142 636). This rejection is respectfully traversed.

The present invention pertains to a method of desulfurizing kerosene or gas oil. As is set forth in instant claim 1, the present invention can have the following important aspects:

- reacting sulfur compounds in a kerosene or gas oil containing aromatic hydrocarbons and at least one sulfur compound selected from the group consisting of thiophene compounds, benzothiophene compounds, and dibenzothiophene compounds among themselves and/or with aromatic hydrocarbons by bringing the kerosene or gas oil into contact with:

a solid superacid catalyst selected from the group consisting of sulfated zirconia, sulfated alumina, sulfated tin oxide, sulfated iron oxide, tungstated zirconia, and tungstated tin oxide, and

optionally the kerosene or gas oil is brought into contact with a zeolite selected from the group consisting of proton-type faujasite zeolite, proton-type mordenite and proton-type  $\beta$ -zeolite, and having the silica/alumina ratio of 100

mol/mol or less and the content of cations other than proton of 5 mass % or less.

Claim 1 also sets forth that upon contacting the kerosene or gas oil with the solid superacid catalyst, the reaction between the sulfur compounds themselves or between the sulfur compounds and the aromatic hydrocarbons occurs prior to adsorption of the reaction products by the solid superacid catalyst.

In newly independent claim 2 (which has broader transitional language) contact with the zeolite is not optional.

The desulfurization method of the present invention has unexpected results, which are demonstrated by the Examples in the specification and Figure 1, which is reproduced below.

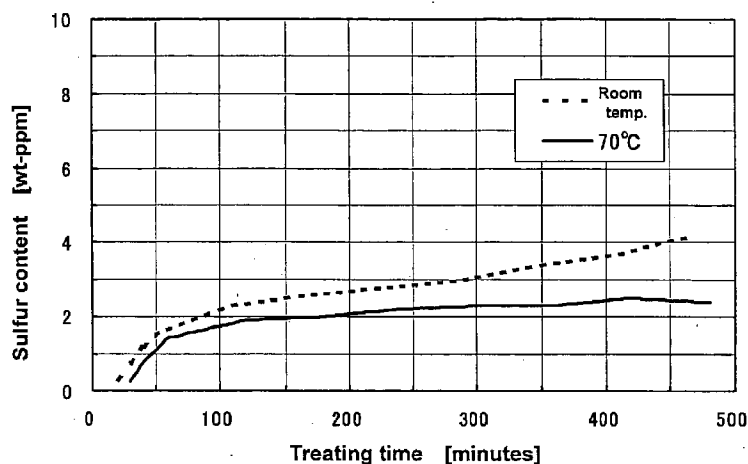


Fig. 1

Toida does not disclose a kerosene or gas oil being brought into contact with a solid superacid catalyst selected from sulfated zirconia, sulfated alumina, sulfated tin oxide,

sulfated iron oxide, tungstated zirconia and tungstated tin oxide, by which contact sulfur compounds in a kerosene or gas oil react among themselves (sulfur compounds) and/or with aromatic hydrocarbons. Nor does Toida suggest such a step.

The Office acknowledges that Toida does not teach or suggest desulfurizing hydrocarbons using solid superacid catalyst. Accordingly, the Office cites Imura et al. which discloses using solid superacid catalyst, and alleges that it is obvious to use solid superacid catalyst of Imura et al. in the invention of Toida.

Imura et al. does disclose contacting light hydrocarbon oil with solid superacid catalyst. However, the process undergoes hydrogenolysis and isomerization leading to desulfurization. Further, the light hydrocarbon oil used in Imura et al. is light naphtha (See page 5, lines 42-58, [0034] and (0035]), and not kerosene or gas oil.

On the other hand, the present invention does not desulfurize by hydrogenolysis, but desulfurizes where the sulfur compounds are made to react among themselves and/or with aromatic hydrocarbons followed by adsorption desulfurization.

The mechanism of desulfurization is totally different between Imura et al. and the present invention.

It is noted that when sulfur compounds are brought into contact with solid superacid catalyst **in the presence of**

**hydrogen**, desulfurization by hydrogenolysis (Imura et al.) predominantly occurs.

Importantly, in this Imura et al. process, the reaction among sulfur compounds or the reaction of sulfur compounds with aromatic hydrocarbons (as per the present invention) does not occur. Hence, it is necessary to bring sulfur compounds into contact with the catalyst in the absence of hydrogen for adsorption desulfurization of the present invention.

At paragraph 30 at page 11, the Office Action asserts that the "*comprising*" language in claim 1 is open ended and does not exclude the presence of hydrogen. However, claim 1 has been amended to use "*consisting essentially of*" language that excludes the presence of hydrogen.

Moreover, the Office Action acknowledges that Toida does not disclose zeolite with a content of cations other than proton of 5 mass % or less, and the solid superacid catalyst, but asserts that this would be a result effective variable obtainable by routine experimentation.

However, the Examples in the specification paint a different picture. For instance, Example 6 utilizes HY zeolite as an acid catalyst, where Example 6-1 has 3 mass % Na, Example 6-2 has 0.2 mass % Na and Example 6-3 has 0.03 mass % Na. In contrast, Comparative Example 6-1 has 12 mass % Na. The unexpectedly high adsorption capacity when **both** the superacid catalyst and zeolite with less than 5% protons are present (such

as is required in independent claim 2) is clear from Table 5, which is reproduced below.

TABLE 5

	Kind of catalyst or adsorbent	SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> ratio	Adsorption capacity [g-S/kg-adsorbent]
Example 6-1	H—Y zeolite	5.5	22
Example 6-2	H—Y zeolite	6.0	52
Example 6-3	H—Y zeolite	360	19
Example 6-4	H-β zeolite	27.4	40
Comparative example 6-1	NaX zeolite	2.5	17
Comparative example 6-2	Copper oxide supported on alumina	—	12
Comparative example 6-3	Nickel oxide supported on alumina	—	9
Comparative example 6-4	Zinc oxide	—	4

The other Tables tell a similar story. This is clearly a non-linear effect that is unobtainable by routine experimentation.

Other distinctions of the present invention over the applied art are of record in the application which, for brevity, are not repeated here.

As a result, one of ordinary skill and creativity would not produce independent claims 1 and 2 of the present invention from a knowledge of Toida and Imura et al. A *prima facie* case of unpatentability has thus not been made. Also, the unexpected results of the present invention would fully rebut any unpatentability that could be alleged. Claims depending upon claims 1 or 2 are believed to be patentable for at least these reasons.

This rejection is believed to be overcome, and withdrawal thereof is respectfully requested.

**New Claims 22-29**

Claims 22-29 have been newly presented for consideration on the merits. It is believed that new claims 22-29 are instantly patentable for at least the reasons set forth above.

**Conclusion**

Allowance of all the claims is respectfully requested.

The Commissioner is hereby authorized in this, concurrent, and future submissions, to charge any deficiency or credit any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

YOUNG & THOMPSON

/Robert E. Goozner/  
Robert E. Goozner, Reg. No. 42,593  
Customer No. 00466  
209 Madison Street, Suite 500  
Alexandria, VA 22314  
Telephone (703) 521-2297  
Telefax (703) 685-0573  
(703) 979-4709

REG/lrs